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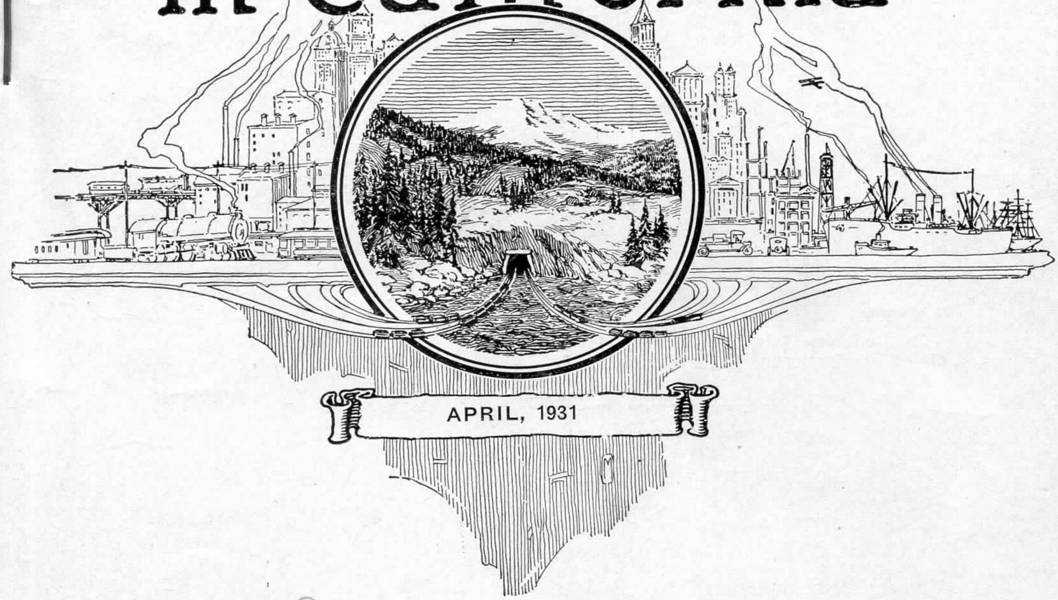

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PRELIMINARY REPORT OF THE GEOLOGY OF SANTA CRUZ ISLAND, SANTA BARBARA COUNTY, CALIFORNIA[1]

By William W. Rand

INTRODUCTION

This paper presents briefly some of the results of a five-months' geological examination of Santa Cruz Island, carried on during the summers of 1928, 1929, and 1930. It is a short preliminary statement which the writer expects to amplify later.

Location.

The Santa Barbara or Channel Islands comprise a group of four islands, flanking the coast of southern California between the longitudes of Ventura and Point Conception, and separated from the coast by the Santa Barbara Channel, the width of which is about twelve miles on the east, and about twenty-seven miles on the west. All of the islands are included in a rectangle bounded by 33° 50′ and 34° 05′ north latitude, and by 119° 20′ and 120° 30′ west longitude.

Santa Cruz is the largest, longest, and highest of the four islands. Its area is 91.16 square miles, extreme length 23.47 miles, breadth, from 1.78 to 6.78 miles, and maximum elevation 2,407 ft. Prisoners' Harbor, on the north side, is just twenty-seven miles due south of the Santa Barbara wharf.

Other Investigations of the Region.

In 1889, W. A. Goodyear, then Field Assistant to the State Mineralogist, spent about three weeks on Santa Cruz Island, and published his observations in the Ninth Annual Report of the State Mineralogist.[2]

In 1929, more than a year after the writer began his field study, an economic investigation of part of the island was undertaken, but until the present time, Goodyear's report is the only published account of the geology of the entire area.

GENERAL GEOLOGY

The formations exposed on the Island range in age from pre-Cretaceous to Recent, but do not furnish a complete record of that time interval.

The oldest rocks are foliated chlorite-bearing schists, which were intruded by quartz-diorite of two ages. This complex was deeply eroded, and unconformably overlain by Eocene and Miocene sediments. Large quantities of volcanic breccias and agglomerates, with a lesser amount of flows, were extruded in Middle Miocene time, and were followed abruptly by marine siliceous shales typical of the upper part of the Monterey Group. The shales and underlying rocks were folded, eroded, and then overlain in places by thin almost flat-lying Pliocene beds, of which only a few small patches remain. Later, marine terraces were cut at several levels, and show that after Pliocene time the Island was elevated to different heights; but drowned valley-mouths show that the latest movement was slightly downward.

[1] Published by permission of the Department of Geology, University of California, and through the courtesy of the Santa Cruz Island Company and National Trading Company.

[2] Goodyear, W. A., Santa Cruz Island: Ninth Annual Report of the State Mineralogist, for the year ending December 1, 1889 (1890).

STRATIGRAPHY

Pre-Cretaceous Rocks.

Chlorite schist.

The oldest rock on the Island is dull olive-green schist which weathers brick-red. It is composed of abundant chlorite with quartz and feldspar, a considerable amount of epidote and titanite, and some magnetite and pyrite. The planes of schistosity are clear, but it is not certain whether they follow original bedding planes. The schist is rather basic which suggests that the original rock was a basic tuff, and in some samples textures suggestive of basaltic or andesitic rocks remain. The mineral assemblage and typical crystalloblastic texture indicate metamorphism in the epi-zone. No statement can yet be made concerning the age of these rocks except that they are older than the quartz-diorite intrusions. The writer saw no soda amphiboles in this schist and there appears to be no reason to consider it a member of the Franciscan formation.

Older quartz-diorite.

The first rock which intruded the old schist is light greenish-gray, coarse-grained, massive, highly quartzose quartz-diorite, sericitized and epidotized. Dynamic metamorphism has altered this rock to gneiss where thin apophyses of it cut the schist.

Younger quartz-diorite.

The second rock to intrude the schist consists mainly of quartz-hornblende diorite whose composition and texture are variable from place to place. In contrast to the earlier intrusion, it is fresh; the hornblende is not chloritized and the feldspar shows very little sericitization. The minerals are not strained except locally near the contact with the schist and earlier quartz-diorite. It contains a notably higher proportion of hornblende, and lower proportion of quartz than the rocks of the first intrusion. It has been cut by acid dikes and later by basic dikes.

Eocene.

Martinez formation.

The oldest sedimentary rocks exposed are of Lower Eocene (Martinez) age. These consist of rusty-tan colored conglomerate, sandstone and sandy siltstone, exposed over only a small area; the thickness is indeterminate because the base is not exposed. The following fossils were found in them:

Cucullaea (Cyphoxis) mathewsoni Gabb.
Glycimeris major Stanton.

Callocardia simiensis Nelson.
Turritella (Haustator) pachecoensis Stanton.
Turritella infragranulata Gabb.

Domengine formation.

The Domengine formation, which overlies the Martinez, is divided into a lower siltstone, a middle sandstone and conglomerate, and an upper siltstone. The siltstones are very much alike and could not be mapped separately if the intervening sandstone and conglomerate were absent. The siltstones are light gray when fresh, but weather to light tawny yellow. They are rather poorly indurated except for thin intercalations of calcareous sandy silt, and are thinly and evenly bedded. Foraminifera are abundant in certain layers, and megascopic fossils are well preserved in the harder sandy beds.

The middle member is composed of well indurated sandstone and massively bedded conglomerate made up of well rounded boulders averaging three to four inches in diameter. Porphyritic rhyolite, andesite, various plutonic rocks, quartzite, and limestone are all represented, but no Franciscan rock types occur. Irregular lenses and thick beds of gray coarse-grained arkose (weathering rusty tan) occur in this member and are notable for the abundance of biotite. The proportion of conglomerate to sandstone decreases rapidly to the south and east; in the most easterly exposures conglomerate is almost absent.

Fossils were found throughout the formation, and include the following forms:

Globularia hannibali Dickerson.
Cylichnina tantilla Anderson & Hanna.
Venericardia hornii Gabb var.
Corbula cf. parilis Gabb.
Ostrea cf. idriaensis Gabb.
Turritella applini M. Hanna.
Turritella variata Conrad.
Amaurellina (Euspirocromium) clarki Stewart.

Miocene (Monterey Group).

Vaqueros formation.

Unconformably overlying the Domengine is the Vaqueros formation, which consists of fairly well-bedded conglomerates, with intercalated beds of coarse sandstone. The boulders of the conglomerates are mainly of plutonic rocks, together with porphyritic volcanics probably derived from the Eocene conglomerate below. Franciscan fragments are extremely rare in the Vaqueros. The following fossils, collected from the sandstone, form the basis for the age determination:

Pecten estrellanus Conrad.
Pecten miguelensis Arnold.
Pecten vanvlecki Arnold.
Cardium vaquerosensis Arnold.
Phacoides cf. nuttalli Conrad.

On the north flank of the Christy anticline the Vaqueros beds are much thinner than on the south flank, as will be seen from the map and section. A pronounced unconformity separates the Vaqueros from the Eocene, and boulders of fossiliferous Eocene sandstone occur in the basal beds of the Vaqueros.

Temblor formation.

San Onofre Breccia.

The San Onofre breccia, bluish-gray, bedded sandstone, conglomerate and breccia, composed in greatest part of flakes and blocks of various types of schists, makes up the lower part of the Temblor formation, which overlies the Vaqueros.

Soda amphiboles such as are characteristic of the Franciscan rocks are more or less abundant in all of the schists, and the rocks correspond in essential characters to the San Onofre schist-breccia with gray sandy matrix, described by Woodford.[3] Breccia with earthy matrix was not found. The maximum diameter of the blocks is about five feet, considerably less than that of the blocks at the type locality. Cross-bedding is distinct at several places, and indicates a source to the west. Because no typical Franciscan bedrock occurs on the island, it is not possible to fix the position of the source rock, but it was very probably somewhere west of the present Island.

At the base of this breccia there is a siltstone member about 150 feet thick, which contains typical Temblor fossils, just as do the sandstones above the breccia; thus the Temblor age of the breccia is well established.

Upper Sandstone and Conglomerate.

Well-bedded, fossiliferous sandstones and conglomerate, which weather to tan, rest on the San Onofre breccia, in places with erosional unconformity. The sandstones, locally present at the base, grade upward and laterally into thick-bedded conglomerate composed mainly of acid, porphyritic volcanic rocks. There is very little admixture of the Franciscan rock types so abundant in the San Onofre below. The sandstone carries fossils of Temblor age.

Blanca tuff.

An extensive mass of distinctly bedded, water-deposited, acid to intermediate crystal-vitric tuffs, and conglomerates make up the Blanca tuff. Near the top there is a thin flow of andesite, preserved now in only two small remnants, on the tops of ridges. This flow is probably the forerunner of the thick series of volcanics to the north. The rocks of this unit dip southerly and form conspicuous, nearly white outcrops. Cross-bedding in the tuffs and conglomerates shows derivation from the north.

Volcanics.

Andesite and basalt breccias, agglomerates, and flows are thickly and irregularly bedded; with a few intercalations, usually less than 100 feet thick, of thin-bedded muddy tuffs. The latest flow exposed is of dacite, and is mapped separately. In petrologic character, type of deposition, and probably also in their age, these rocks correspond closely to those in the western Santa Monica Mountains.

[3] Woodford, A. O., The San Onofre Breccia, Its Nature and Origin: Univ. Calif. Pub., Bull. Dept. Geol. Sci., Vol. 15, No. 7, pp. 159–280, 1925.

From the map it can be seen that the volcanics are confined almost entirely to the north side of the Santa Cruz Island fault. West of the Isthmus, they dip northerly, while to the east of it, they have been folded to form an anticline whose axis trends northwest.

Siliceous shale.

The siliceous shale rests directly upon the volcanic rocks, with a sharp contact. This member includes yellowish gray, thinly laminated, siliceous and tuffaceous, foraminiferal and diatomaceous shale; dark gray bituminous shale; chert; and thin beds of sparsely fossiliferous limestone. A few thin beds of sandstone and of acid vitric tuff are present. A fauna from the base of this unit includes:

Mollusca

Arca obispoana Conrad.
Venericardia montereyana Arnold.
Pecten peckhami Gabb.

Foraminifera

Valvulineria californica Cushman.
Siphogenerina cf. collomi.
Nonionia sp.

Upper Pliocene.

Santa Barbara beds.

The Santa Barbara beds overlie the siliceous shales of the Monterey group with erosional and slight angular unconformity. They are gray, fairly well-bedded, highly fossiliferous shell-sandstones, composed mainly of finely broken shell fragments, weakly cemented with calcite. The beds contain many shells that are rounded as though by attrition on a beach. A number of fossils characteristic of the Santa Barbara beds on the mainland were collected.

Pleistocene.

Marine terrace deposits.

Pleistocene terrace deposits occur at several elevations, and consist of poorly sorted conglomerates and coarse pebbly sandstones, highly lenticular and cross-bedded, dipping seaward at low angles.

STRUCTURE

Faults.

The most conspicuous structural feature is the Santa Cruz Island fault, dividing the Island lengthwise into two parts which are geologically quite unlike. No siliceous shale and almost no extrusive volcanic rocks appear south of the fault; on the other hand, no rocks older than the Middle Miocene volcanics are exposed north of it. The fault is a remarkably sharp break so that in many exposures there is almost no gouge. Movement has occurred after the deposition of the terrace material, causing a vertical displacement of the terrace which amounts to at least fifty feet, and is shown on the beach near Christy Ranch. Offset streams show a relative westward displacement of the north side.

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Other faults of lesser displacement roughly parallel the Santa Cruz Island fault on the south, and still others cross it at high angles near the Isthmus.

Folds.

The Christy anticline has been formed by folding which occurred after the deposition of the Eocene sediments, and again after the Miocene deposition; the later folding has produced a new axis in the Miocene slightly south of the axis in the Eocene. Folding or tilting has caused the Blanca tuff to dip southerly and has also increased the northerly dip of the volcanics so that the wider part of the Island somewhat resembles a large anticline. Several short, gentle folds are present in the shale of the Isthmus, and a longer fold crosses the volcanics of the eastern end.

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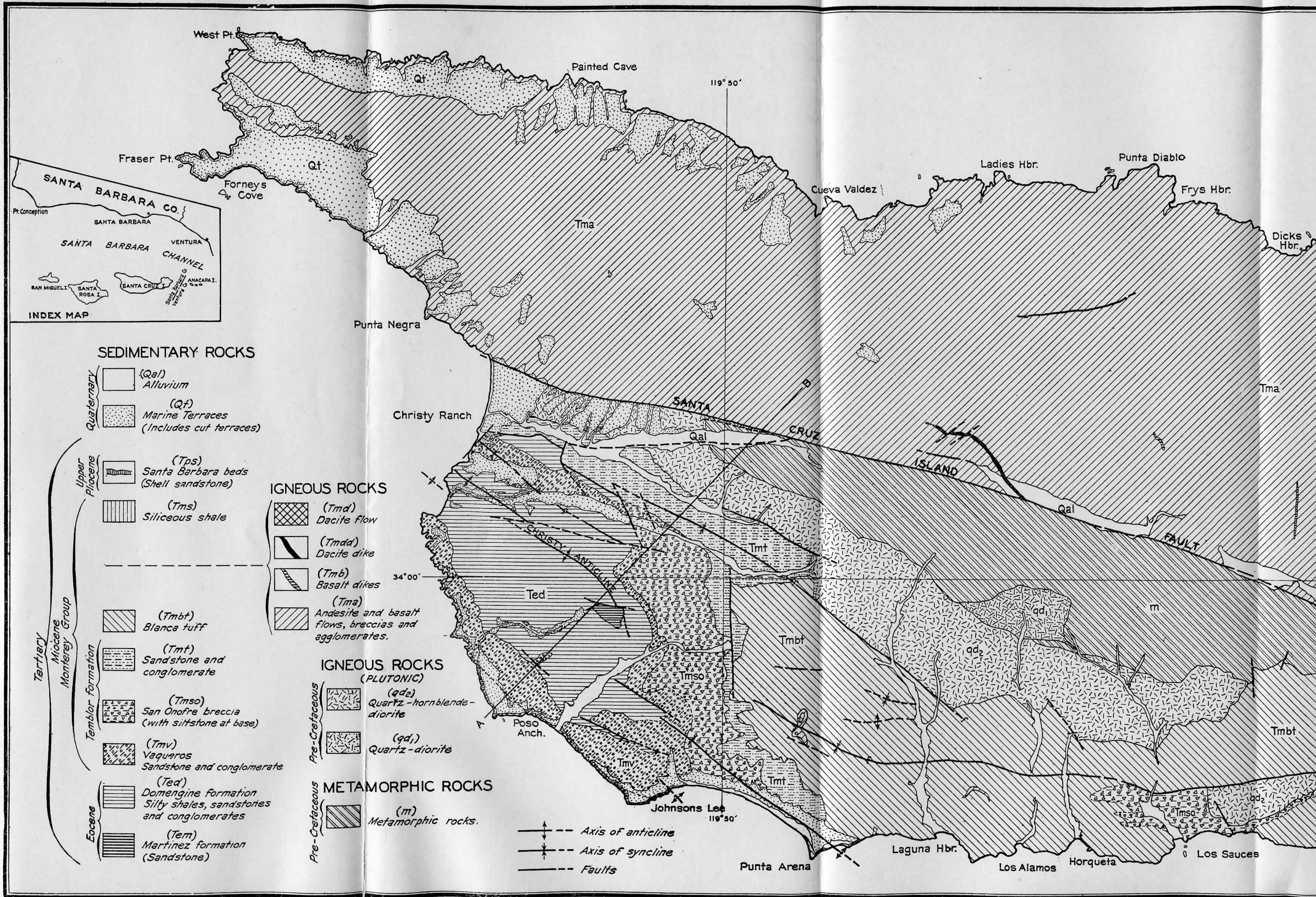
CALIFORNIA STATE DIVISION OF MINES
WALTER W. BRADLEY, STATE MINERALOGIST



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GEOLOGIC BRANCH
OLAF P. JENKINS, CHIEF GEOLOGIST.

GEOLOGIC MAP OF SANTA CRUZ ISLAND CALIFORNIA

BY
WILLIAM W. RAND
1931